Optical access networks:
Business guidelines and policy recommendations

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ABSTRACT
Within the European FP7 project OASE, we have studied different business models for optical access networks. Based on an exploration of existing FTTH cases in Sweden, the Netherland and Germany, we developed a model for a cost-benefit analysis for the physical infrastructure provider (PIP) as well as the network provider (NP). Our evaluations have shown that the business case for the PIP is very difficult, even impossible in sparsely populated areas. Demand aggregation is an effective measure to guarantee earlier return on investment for the PIP. In-house deployment and CPE are significant cost factors for the NP. Business models that allow to allocate these costs to house or home owners should get enough attention. Furthermore, open access on fiber, wavelength and bit stream level allows for additional competition but also leads to additional opportunities and costs. Finally, some cross-sectorial effects can be expected from a fiber deployment. This could be an additional stimulus for national, regional or municipal governments to invest. In this way public support may be desirable.

Keywords: optical access networks, business models, recommendations

1. TYPICAL BUSINESS ROLES IN OPTICAL ACCESS NETWORKS AND IMPACT ON BUSINESS CASE ASSESSMENT FOR A OPTICAL NETWORK DEPLOYMENT

Based on the technical and economic nature of the different parts of the access network, responsibilities are typically split in three conceptual levels. On the lowest level, the physical infrastructure provider (PIP) is responsible for right-of-way, ducts and fibres. The network provider (NP) is responsible for the OSI-layers 2 and 3. In case the wavelength layer (layer 1.5) is applicable, it is typically under the responsibility of the PIP rather then one of several NPs offering connectivity in the same area. Finally, there is the service provider (SP) that is responsible for the actual service offer that could be very diverse (single versus multi-play package, streaming versus on-demand services, etc.). The passive infrastructure is typically characterized by high up-front investments, low economies of scale and is often subject to regulation. The network layer is characterized by higher recurring costs and higher economies of scale. The arguments justify the suggested role separation. PIP responsibilities are typically taken up by infrastructure players like real estate companies, municipalities and utilities. NP players, on the other hand, typically own and operate network equipment.
Reference next-generation access areas have been described (urban, dense urban, rural) as well as different reference adoption curves (likely, aggressive and conservative), based on which the costs for deployment and operations of the OASE architectures have been calculated [1]. Next to that, revenue models have been developed for PIP and NP, based on observed pricing schemes for real-life optical access cases..

2. HOW TO GET TO A FIBRE INFRASTRUCTURE?

It is commonly assumed that fibre infrastructure requires a huge upfront investment, and our analysis confirms that. It is therefore important to understand under what circumstances the revenues can match that investment. The revenue model developed within OASE, based on information from existing cases and current regulatory price settings in countries under study, suggests that monthly revenue of €10 per residential connection for the PIP is common [2]. Our analysis shows that with such revenue compared to the green-field investment cost, the business case for the PIP only proves viable in a dense urban area with aggressive adoption.

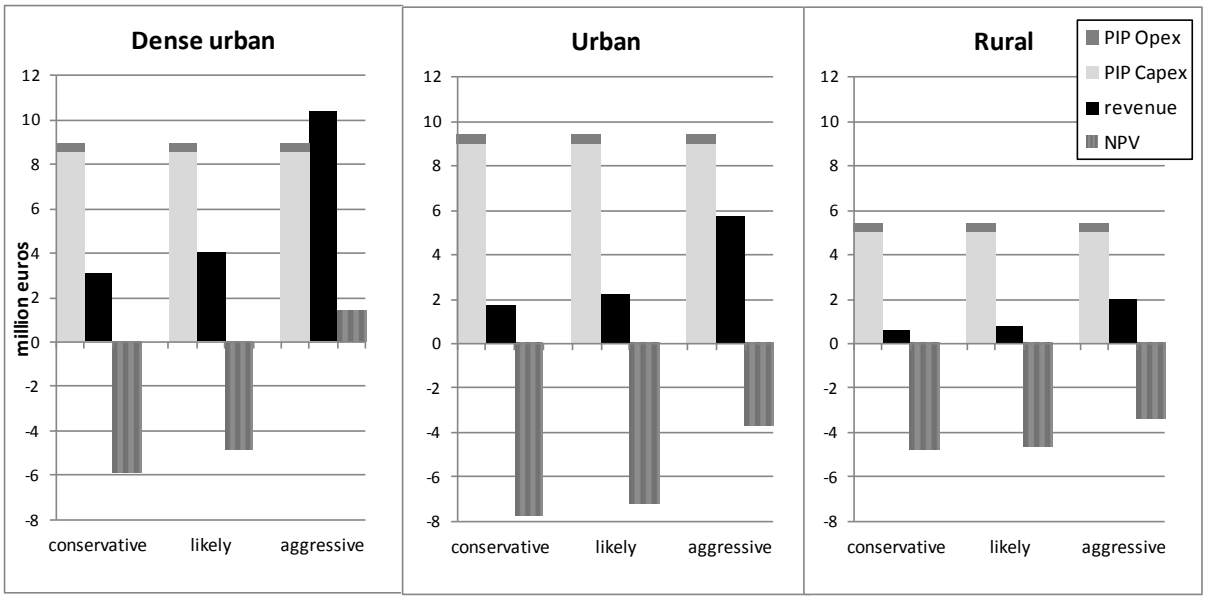

Figure 2-1: Cumulative costs, revenues and NPV for the business case of the PIP (discount rate = 5%, planning horizon = 20 years)

The business case can however be improved by a number of factors (which may help explain the fact that several real-life deployments have been made in an economically sustainable way). The following measures were analysed:

- Demand aggregation, i.e., pre-subscription of interested customers to the FTTH offer, leading to an assured substantial revenue stream for the PIP from the start of the project, therefore heavily reducing the investment risk: a level of demand aggregation of 40% can nearly make all scenarios in urban and dense urban areas profitable [3].

- Duct reuse leads to significant trenching cost reduction: 14 to 32%, depending on the area under study. Hence joint roll-out of different utility networks (fibre, electricity, water) are to be preferred, so that utility companies might become preferred PIP players. It should be noted that, although duct reuse leads to significant cost savings, it also leads to a lost opportunity cost, since the owner could lease out these ducts to other parties when not using them for deploying fibre.

- Fibre lease outside the broadband access. Besides the revenues accruing from the residential market value chain, significant revenue is to be found from leasing fibre for e.g., mobile backhauling, point-to-point connections for large businesses, banks and public institutions, transport for operators, etc. This revenue is in some neutral open-access municipal networks can amount to be larger than the residential market revenue [3].

- Longer payback term. As players with different financial and economic background can take up the role of a PIP, different values for the weighted average cost of capital (WACC, reflecting the needed return on the investment) can be considered. Assuming a discount rate of 5%, a discounted payback time of less than 40 years was observed in the dense urban scenario, independent from the adoption curve.

For some areas, even with the measures suggested above, green-field fibre deployment may remain economically infeasible. In those cases government intervention could be justified by positive externalities, i.e. indirect or cross-sectoral effects accruing outside the broadband access value chain, but which are of significance for the economy and society at large [4]).
Public support should be focused on the PIP layer. Deployment of the physical infrastructure is mainly CAPEX driven, therefore support may be granted in terms of long-term loans, or long depreciation periods, in order to increase the investment horizon.

3. OPEN ACCESS FROM A BUSINESS PERSPECTIVE

Open access leads to two important sets of advantages. First, infrastructure sharing considerably reduces investment cost, which is currently the single biggest obstacle to fibre network deployment. Second, it enables competition between service providers, which is expected to lead to lower prices for the end users, and to increased network management efficiency and service innovation

However, the presence of different actors on different layers, requires an open access interface. We have modelled the open access interface on three layers: dark fibre, wavelength and bit-stream, depending on the architecture under study [1] and calculated the costs in terms of extra equipment, as well as management, process and business interfaces (Figure 1). The combination of these equipment related costs, together with the management, process and business related costs form the so-called transaction costs.

The equipment related cost for open access varies for the three layers under study, and has as such been evaluated separately. Open access on the fibre layer clearly provides the greatest degree of flexibility thanks to the ease of deployment of multiple network providers potentially opting for heterogeneous network technology. While open access on the wavelength layer is possible and comes for a marginal increase in cost, however, diseconomies of scale associated with the use of PON architectures by network providers give a disincentive to utilize such a scheme for small numbers of users. Finally, bit-stream level open access will be possible with all system variants, and there are small additional overheads associated with providing access at this level, while the actual additional equipment related costs will be close to negligible. In the other hand, it also reduces the ability to differentiate services between operators.

Secondly, open access entails a management and process related cost, including all kinds of patching which are related to the provisioning process (patching can amount up to €150 in case of fiber open access) or logical connection for a bitstream product.

Finally, business related costs are the collection of search and information costs (related to the level of standardization and documentation of the requirements of the other actors), bargaining costs (for negotiation of the contracts) and enforcement costs (ex-post costs to ensure that everything operates according to the agreements). These costs typically range between 8% and 15% of turnover for PIP and NP.

From the perspective of transaction cost reduction, there is a clear potential gain in promoting standardization, both at technical and business level.

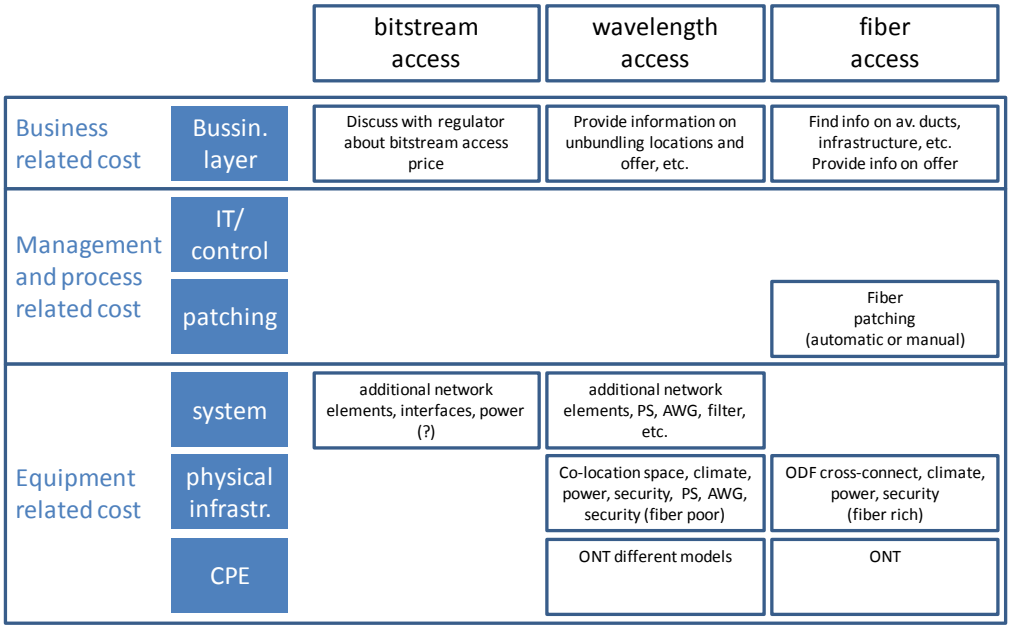

Figure 1: Different costs related to open access

4. VIABILITY FOR THE NETWORK PROVIDER

Our analysis showed that NPs can work cost-efficiently on top of an open infrastructure [3]. However, in-building deployment and CPE are significant cost factors that need to be addressed (entirely accounted for by the NP as we assume to PIP to terminate in the building basement). If this dominant in-building cost could be shifted to another player (house owner or partially tenant), the business is positive for all scenarios (areas and adoption curves), with slight cost advantages for G-PON 1:32 over AON. When assuming a high take-up for NGOA technologies (NG AON, WS WDM PON and Hybrid PON), there is a reasonable business case in the order of €10 per customer per month (matching the indicative revenues for the NP found in existing case studies [2]).

Observing the case studies, we see that there is a limited set of NPs offering network connectivity in a certain area. Depending on the situation, either one NP wins the tender and offer connectivity in exclusivity for a predetermined period of time, or freely choose between different NPs offering connectivity to them. In any case, each end-user would be connected to one NP at one point in time.

In summary, we find that NPs can easily be attracted on top of an open infrastructure, especially if they can allocate the in-building costs for house or home owners (or partially to tenants). Some examples exist of business cases in which property owners and tenants agree to a rent increase when in-building networks are installed (e.g., the infrastructure is viewed as an upgrade of the building, in the same way as a new elevator or a facade renovation would).

5. RECOMMENDATIONS AND CONCLUSIONS

Based on our findings concerning the economic viability for the different actors involved in an optical access deployment, we have formulated some recommendations for policy makers.

From an open access point of view the preferred way of opening up a fibre based access network remains either open fibre access, associated with the high cost of deploying additional fibres and installing a fibre P2P infrastructure, or bit-stream open access as basically used today.

The business case for the PIP remains very difficult, even when using measures like demand aggregation and duct reuse. However, a lot of indirect or cross-sectoral effects can be expected from a fibre deployment. This could be an additional stimulus for national, regional or municipal governments to invest.

The construction of passive infrastructure is to be shared on equal and non-discriminatory ground. If the PIP is required to share the passive infrastructure or the PIP is the only part of the value chain taken over by a player, the deployed infrastructure should be technology agnostic, meaning that fibre consolidation should take place at flexibility points in which fibres can be connected, and in which both active and passive equipment can placed.

Public support should be focused on the PIP layer. Deployment of the physical infrastructure is mainly CAPEX driven, therefore support may be granted in terms of long-term loans, or long depreciation periods, in order to increase the investment horizon.

For the NP, in-house deployment and CPE are significant cost factors. Business models that allow allocating these costs to house or home owners should get enough attention. However, public support to the NP is unadvisable in the long term.

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